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LASER RANGING AND VERY-LONG-BASELINE INTERFEROMETRY FOR GEODETIC APPLICATIONS

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Unclassified SECURITY CLASSIFICATION OF THIS PAGE (When Date Entered) READ INSTRUCTIONS BEFORE COMPLETING FORM ORT DOCUMENTATION PAGE 2. GOVT ACCESSION NO. 3. RECIPIENT'S CATALOG NUMBER AFGL FR-78-0057 TITLE (and Subtitle) Final Pepti Laser Ranging and Very-Long-Baseline 1 Jul 074-30 Sept Interferometry for Geodetic Applications, 5 F19628-75-C-058 Irwin I. Shapiro C. C. Counselman, III PERFORMING ORGANIZATION NAME AND ADDRESS PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Department of Earth and Planetary Sciences 61102F Massachusetts Inst. of Technology 23096101 Cambridge, MA 02139 11. CONTROLLING OFFICE NAME AND ADDRESS February 1978 Air Force Geophysics Laboratory Hanscom AFB, Massachusetts 01731 Monitor/Theodore E. Wirtanen/LWG 14. MONITORING AGENCY NAME & ADDRESS(II different from Controlling Office) 15. SECURITY CLASS. (of this report) Unclassified 154. DECLASSIFICATION/DOWNGRADING 6. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited 17. DISTRIBUTION STATEMENT (of the abetract entered in Block 20, if different from Report) 18. SUPPLEMENTARY NOTES 19. KEY WORDS (Centinue on reverse side if necessary and identify by block number) Lunar Lunar libration Onsala Space Observatory Laser Very-long-base interferometry LAGEOS Earth rotation ABSTRACT (Continue on reverse side if necessary and identify by block number) Three distinct tasks were undertaken to advance the application of space techniques to the measurement of geodetic parameters: error analyses were performed to estimate the accuracy with which the locations of satellite tracking stations and the motion of the earth's pole may be determined from laser-ranging observations of the LAGEOS satellite; (if) a numerical model of the moon's rota-

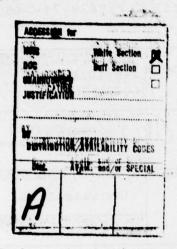
tion was developed to support the analysis of lunar laser ranging

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observations; and (iii) a very-long-baseline interferometry (VLBI) system was constructed and installed at the Onsala Space Observatory in Sweden for use in a program to monitor the earth's rotation through observations of extragalactic radio sources. The details of this work have been described in three previously published reports.



The work done under this contract falls primarily into three distinct categories: (i) error analysis of possible laser ranging to the then-proposed, now-orbiting LAGEOS satellite; (ii) development of a numerical model of the moon's libration; and (iii) the development and deployment of a dual frequency band receiver system for a very-long-baseline interferometer. We discuss our results only briefly below since we give reference to the appropriate reports which present fuller discussions of the individual subjects.

The error analysis of laser ranging to the LAGEOS satellite was undertaken to estimate the accuracy with which both the locations of the laser stations and the motions of the earth's pole could be determined. Five such analyses were performed to simulate the results obtainable with 14 laser stations employed to range to LAGEOS which was assumed to be in a polar, near circular orbit with 10,000 km semimajor axis. The determination of the laser sites typically had standard errors of about 2 cm; the corresponding uncertainties in the other components of the laser site coordinates and in the pole position of the earth typically ranged from about 2 to 10 cm. Further details are given in Reference 1.

In order to best analyze laser ranging observations of the moon to determine relevant geophysical information, we developed our accurate numerical model of the moon's libration. In particular, we developed the equations of motion, and the variational equations, for the moon's rotation in an inertial coordinate system. The results were compared with a similar model, developed at JPL, that was referenced to a rotating coordinate system. The detailed derivation of the relevant equations and the partial derivatives, and the detailed comparison, is contained in Reference 2.

To measure accurately variations in the rotation of the earth with the technique of very-long-baseline interferometry (VLBI), we developed, constructed, and tested a dual frequency, S- and X-band receiver system similar to that described in Reference 3. This system was deployed at the Onsala Space Observatory in Sweden for initial test in late September, 1977. The test seemed to be successful, but the data analysis could not be completed before the end of this contract. The VLBI receiver system is, of course, intended for future use in a program to monitor the earth's rotation.

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